Italy, AGMIP Maize: analysis of the protocol with SARRA -H

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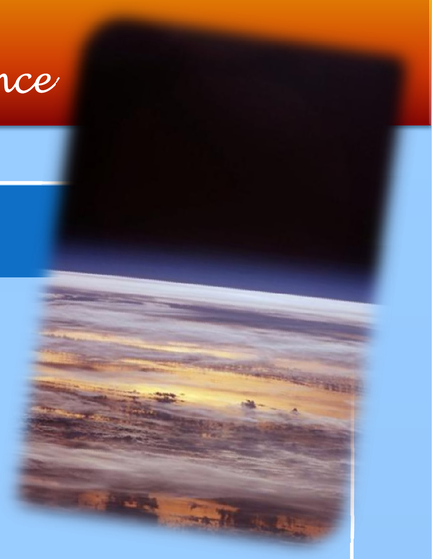


AGMIP protocol to test the effect of temperature, CO2 and N

Calibration on 4 sites

USA, 167kg N.ha^{-1}, **no irrigation**
FR, 255kg N.ha^{-1}, irrigation
Br, no N, **no irrigation**
Tz, 61kg N.ha^{-1}, irrigation
(short rainy season)

Sensitivity analysis on temperature, CO2 and N

Use of as default the management practices given in the experiments.

Main assumptions

Consider the same initial soil water and sowing date as in the experimental dataset for the scenario analysis (testing effect of temperature, CO2 and N).

→ No irrigation in USA and Brazil.

→ Irrigation in France and Tanzania.

Questions

1. Why not using the **soil water dynamics** simulated within the model, rather than a fixed soil initial water?
2. By not irrigating, we might **introduce water stress**. What effect does it have on our simulations?
3. If we want to capture realistic management practices, should we not consider **sowing date according to previous rain**, to optimize crop emergence)?

METHODOLOGY

→ Use the soil water dynamics from SARRA-H to test the impact initial soil water on simulations for the different sites.

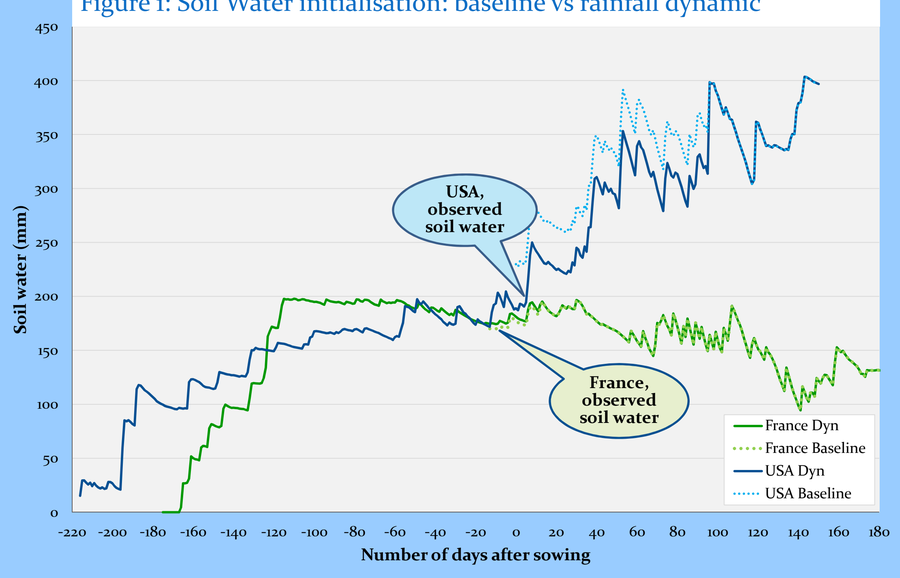
→ Use of automatic irrigation to determine the potential simulation of water stress in non irrigated situation.

→ Use of the potential sowing date routine from SARRA-H to test the impact of the sowing date defined according to previous rain.

ANALYSIS

→ Use the soil water dynamics from SARRA-H to test the impact of initial soil water on simulations for the different sites.

Figure 1: Soil Water initialisation: baseline vs rainfall dynamic



WATER BALANCE

(a) USA		Initial soil water	Irrigation	Transpiration	Drainage
Baseline	no irrigation	205 (0)	0	357(53)	43(27)
Simulating initial soil water	non irrigated	103(70)	0	280(105)	43(27)
Simulating sowing date	non irrigated	79(53)	0	296(117)	43(27)
Simulating initial soil water	irrigated		**231**(133)	413(43)	50(26)
Simulating sowing date	irrigated		**317**(177)	460(49)	96(24)
(b) BRAZIL		**Initial soil water**	**Irrigation**	**Transpiration**	**Drainage**
Baseline	non irrigated		0	414(49)	82(34)
Simulating initial soil water	non irrigated	84(53)	0	417(49)	82(34)
Simulating sowing date	non irrigated	76(43)	0	421(46)	77(32)
Simulating initial soil water	irrigated		86(34)	442(29)	86(34)
Simulating sowing date	irrigated		81(31)	456(33)	81(31)
(c) France		**Initial soil water**	**Irrigation**	**Transpiration**	**Drainage**
Baseline	**irrigated**	151(20)	**288**(60)	416(36)	11(7)
Simulating initial soil water	non irrigated	149(23)	0	228(44)	5(5)
Simulating sowing date	non irrigated	149(23)	0	234(48)	5(5)
Simulating initial soil water	irrigated		**282**(64)	417(35)	11(7)
Simulating sowing date	irrigated		**292**(69)	445(42)	11(7)

Table 2: Main water balance component for (a) USA; (b) Brazil; and (c) France

→ **USA:** we show the importance of irrigation to simulate potential growth conditions.

→ **Brazil:** rain seems to be enough; less than 100mm of irrigation is needed for potential growth conditions.

→ **France:** With automatic irrigation, we reproduce the average irrigation needed, as done in the experiment used for calibration.

IMPACT ON YIELD

		YIELD (t.ha-1)		
		USA	**BRAZIL**	**FRANCE**
Baseline*		7.5 (2.1)	7.4(1.4)	9.1(1.0)
Simulating initial soil water	non irrigated	5.4(2.9)	7.5(1.4)	2.8(1.2)
Simulating sowing date	non irrigated	5.1(3.3)	7.5(1.3)	2.8(1.3)
Simulating initial soil water	irrigated	9.6(1.4)	8.1(0.9)	9.1(1.0)
Simulating sowing date	irrigated	**10.6**(1.3)	8.4(0.8)	10.0(1.3)

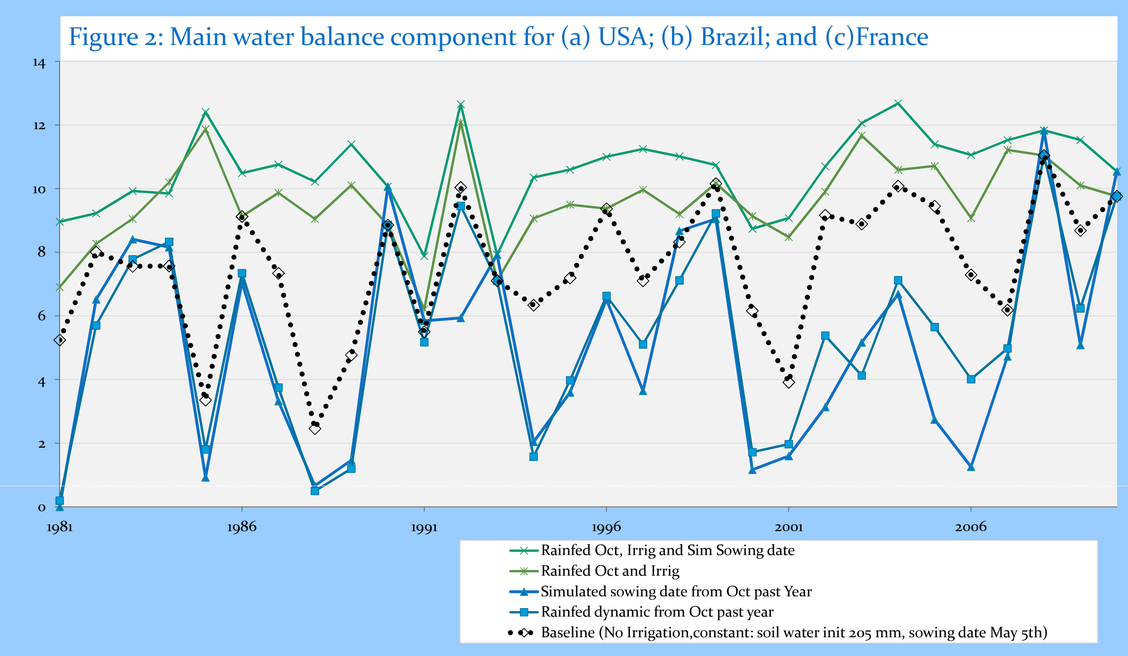
* irrigated for France; non irrigated for USA and Brazil

Table 1: Average grain yield (and standard deviation) from a time series simulation 1982-2010

→ Irrigation: Yield in the USA is impacted by water stress.

→ Sowing date: in potential growth conditions, defining an potential sowing date slightly increase yield. The potential sowing date is on average **1 month before** the defined sowing date (as in the experiment):
USA 1st April instead of 5 May; France 1st April instead of 25April, and Brazil 15 September instead of 23 October

Figure 2: Main water balance component for (a) USA; (b) Brazil; and (c)France



Discussions

→ **US**: not potential production, experiences water stress.

→ **Fr**, **Br**: enough rain or irrigation.

• Water dynamics

If we want to capture the water dynamics and its impact of crop yield, would not it better to simulate the soil water dynamics **considering the rain** before the cropping season **(without irrigation)**?
If so, how **to decouple the water stress effect on the temperature effect** tested in the scenario?

• Sowing date

If we represent the inter-annual variability by considering rain (without irrigation), it seems important to simulate **variable sowing date** corresponding to the right initial conditions (Fig. 2)
If so, we avoid a **sowing date when there is water stress**; we observe a slight gain in yield.

PERSPECTIVES

- **Should we really consider fixed management practices, as defined in the experimentation (irrigation vs. no irrigation, sowing date) if we want to capture annual variability?**
- **Tanzania: not shown in this analysis as maize appears to be mostly planted during the long rainy season in Morogoro (Tumbo et al.*, to discuss with experts), while our data are on the short rainy season. How well do we want to represent farmers' practices?**

AgMIP The Agricultural Model Intercomparison and Improvement Project